1913

557. Certain violet names. Am. Midland Nat. 3: 79–85.

1914

558. Novitates Boreali-Americanae. VII. Fedde, Rep. Spec. Nov. 13: 320–324.
559. Field-notes of western botany. I. Am. Midland Nat. 3: 311–317.
560. Myosurus in Canada. I. Ottawa Nat. 28: 85–87.
561. New species of Ranunculus. Am. Midland Nat. 3: 333–335.
562. Explanatory. Cybele Columbiana 1: 1–6.
563. Violets of the District of Columbia. I. Cybele Columbiana 1: 7–33.
564. Manipulus Malvacearum. I. Cybele Columbiana 1: 33–36.

1929

565. Why the Eschscholtzia? [Posthumous]. Madroño 1: 195–196.

University of Notre Dame,
Notre Dame, Indiana,
January 21, 1936.

GROWTH HABITS OF BARREL CACTI

Robert R. Humphrey

Most desert perennials while in the seedling stage grow in definitely mesophytic situations. As they mature, however, most of them develop under xerophytic conditions, and seem to carry little or no impress of the more humid conditions requisite for germination and early survival. The barrel cacti, or bisnagas (*Echinocactus Wislizeni* Engelmann), as observed within a fifty mile radius of Tucson, Arizona, are striking examples of plants which, though fully exposed to the arid climate when mature, still retain the impress of seedling requirements. Indeed, the excessive development of this early tendency often results in the death of the plants.

For those unacquainted with these interesting cacti a brief description is given. A mature bisnaga is characteristically barrel-shaped and one to four feet high. Individuals much taller than four feet are uncommon, although they may occasionally grow to twice this height. As shown in text figure 1, mature bisnagas are strongly ribbed by a series of vertical ridges which extend the length of the plant and which converge at the growing point at the top. Groups of spines occur at rather regular intervals on each rib. The four central spines of each group are very heavy and strongly hooked downward. A dense circle of orange-red flowers, which persist until late in summer, appears near the center of the top during the summer rains. The yellow,

Fig. 1. *Echinocactus Wislizeni* Engelmann. An unusually large specimen overtopping the vegetation that formerly sheltered it.

rather ornamental fruits may remain on the plant for more than a year.

Bisnagas occur in the greatest numbers on gently sloping *bajadas,* or outwash plains, at the base of scattered mountain ranges, but unlike the sahuaros (*Carnegiea gigantea*) they sometimes occur also on fine alluvial adobe clays of river bottoms.

Wooton and Standley[1] give the range of the species as "Utah and Arizona to western Texas and northwestern New Mexico." It occurs abundantly throughout parts of southern Arizona, including the vicinity of Tucson, below an elevation of 4,500 feet.

In common with such other cacti as the sahuaros and to a certain extent some of the smaller subglobose forms of *Neomamillaria,* bisnaga seedlings seem to establish themselves best under more or less protection during the years that immediately follow germination. It is exceptional for an individual to reach maturity without having had some sort of shelter during the first years of growth. Although this shelter is most commonly afforded by some other kind of vegetation, a rock or similar object may also serve. Shreve[2] has shown that conditions for seedling survival are more favorable in the shade of vegetation than in the open. Possibly such shelter explains the survival of bisnaga seedlings, and the absence of protection may account for the comparatively few that seem to have survived when exposed to the full rays of the sun.

[1] Wooton, E. O., and Stanley, P. C. Flora of New Mexico. Contr. U. S. Nat. Herb. 19: 1915.

[2] Shreve, F. Physical conditions in sun and shade. Ecology 12: 92–104. 1931.

There seems to be an early tendency for a young bisnaga to orient itself toward the sun, or, if the protecting vegetation will not allow this, at least toward the best light available. Apparently this results in the plant's assuming a leaning position from which, even after overtopping the protecting vegetation, it rarely completely recovers (plate XIX, fig. 2). Usually the angle of inclination tends to become greater as the years pass. Although the direction of leaning is usually toward the southwest, sometimes it is in other directions.

Two alternative theories are commonly given to explain the leaning position of the bisnagas. (1) Greater transpiration of the tissues on the warmer southern side of the plants may cause a contraction of the cells on this side. Were there such a tissue shrinkage, it would seem that these plants would assume the shape of an arc, inasmuch as each cell on the southern side would be somewhat shorter than the corresponding cell on the opposite side. But the plants are not curved. They tend to grow straight even though they may lean very markedly. At times, indeed, there may be a curvature in the opposite direction from the general inclination of the plant. An example of this may be seen at the base of the individual shown in text figure 1. (2) The other explanation is that fewer cells are formed on the southern side as the result of unfavorable growth conditions. Were this the case, a plant would become arc-shaped. As shown in figure 2, (plate XIX) unless the direction of growth is abnormally interfered with, each plant tends to grow approximately straight in the same general direction assumed in the seedling stage. As the cactus grows larger and heavier the strain on the rather weak root system increases and the inclination becomes more pronounced until finally the plant is uprooted by its own weight (plate XIX, fig. 1).

Some mature bisnagas occur in the open, but these individuals are usually growing in a leaning position. Since the seedlings grow almost invariably under shelter of some sort and since careful examination of these "open" bisnagas commonly reveals traces of former protecting vegetation, it may be assumed that such individuals have outlived the plants under whose protection they formerly grew. Thus when seeds germinate under such half-shrubs as burro weeds (*Aplopappus fruticosus*) or burro bushes (*Franseria deltoidea*), these apparently shorter lived plants usually die in the course of a few years, leaving the bisnagas standing alone. In those observed instances where the barrel cacti have become established under long lived trees, such as mesquites (*Prosopis* spp.) or palo verdes (*Cercidium* spp.), they usually grow to maturity without any apparent effect on the sheltering trees.

Summary. Seedlings of the barrel cactus commonly become established in the shade cast by other vegetation. As the seed-

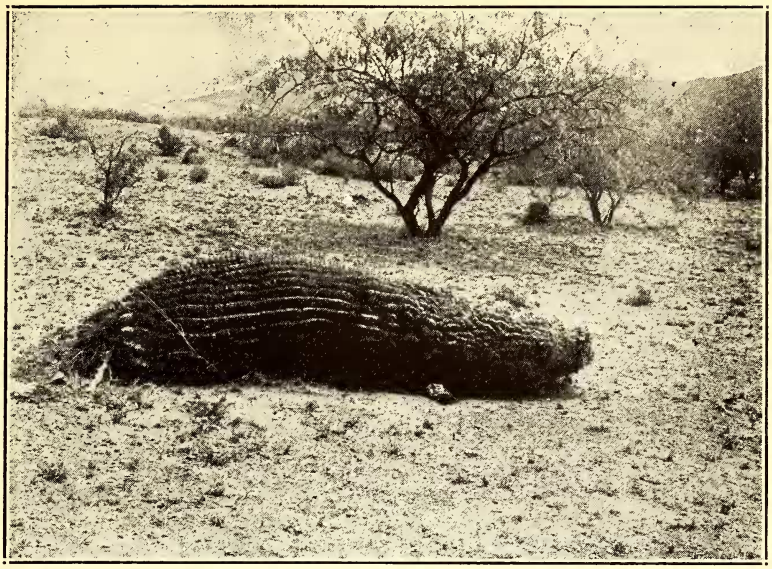

FIGURE 1

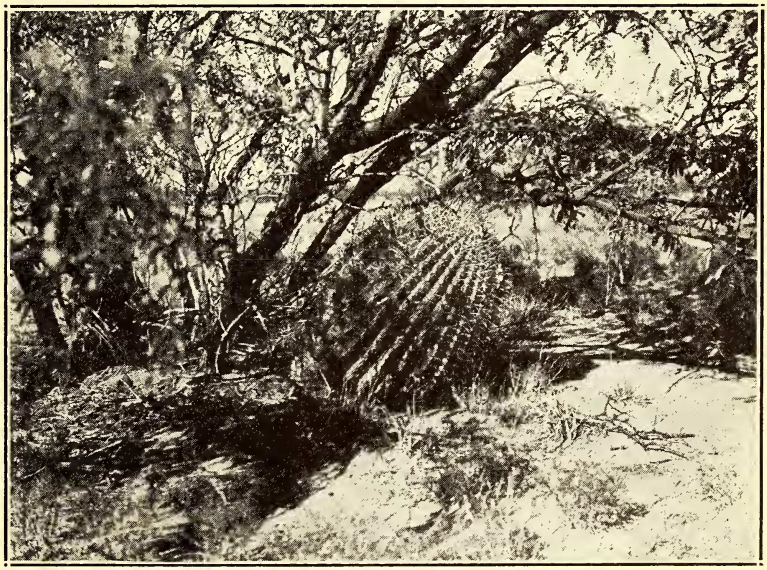

FIGURE 2

PLATE XIX. ECHINOCACTUS WISLIZENI ENGELMANN. Fig. 1. A mature specimen uprooted from an inclining position by its own weight. Fig. 2. A typical specimen growing in the shade of a mesquite. Note the pronounced inclination toward the light.

lings grow, they exhibit a tendency to lean toward the most intense light available. This early leaning habit usually persists throughout the life of the plants and, because of the strain thus put upon the root system, often results in their ultimate uprooting and death.

Southwestern Forest and Range Experiment Station,
United States Forest Service,
Tucson, Arizona, March 9, 1936.

THE RELATION OF BIRDS TO SEED DISPERSAL OF THE DESERT MISTLETOE

R. B. Cowles

Although the especially interesting relationship of birds to the dispersal of seeds of some of the Loranthaceae has been mentioned frequently, it may not be amiss to restate this role in connection with the dispersal of the parasite *Phoradendron californicum,* and also to record a few original observations.

A number of species of birds have been observed feeding on the fruit of the desert mistletoe. Any bird which even occasionally feeds upon the fruit would, to a greater or less degree, be involved in its dispersal. The most important bird would seem to be the silky flycatcher, *Phainopepla nitens,* which most obviously bears a close association to mistletoe dispersal. Other birds observed feeding on mistletoe are the western bluebird, western robin, and desert quail. To this list could be added the linnet, mocking-bird, sage and other thrashers, audubon warbler, and many other less important species. Probably a careful check upon feeding habits of many of the non-resident birds present in the desert during the winter months would show interesting results. It seems obvious that frugivorus birds and the insectivorous species which resort to fruit upon occasions when other food is not available, would find in *Phoradendron* an easily accessible emergency supply with which to eke out the scanty fare available in the desert during the winter months. As an emergency food supply or as a sole source of subsistence, the mistletoe offers an unique advantage to avian life on the desert. Unlike many of the desert products which are dry, bitter or pungent, the mistletoe provides a moderately juicy fruit free from the usual repellents found in desert plants, and one which is most remarkable for the long period during which it is available to desert fauna.

During April, 1935, while on a visit to Borego Valley, San Diego County, California, it was observed that the season's crop of berries was just ending, and at the same locality in November, 1935, the first fruit of the new season was just ripening. Apparently then, there is a period of six months when the berries are